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US REPORT AND RECOMMENDATIONS +3a  
of the  
HORTICULTURAL CROPS RESEARCH ADVISORY COMMITTEE  
345 Developed at its First Meeting  
February 10-14, 1964  
Washington, D. C.

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## Preface

The first meeting of the Horticultural Crops Research Advisory Committee was held in Washington, D. C., on February 10-14, 1964, with fifteen of the nineteen members in attendance. Eyvind M. Faye, Henry A. Mathews, Malcolm J. Reid, and Charles M. Sherrill were unable to attend.

As a basis for its comments and recommendations, the Committee made a systematic review of the Department's research program on horticultural crops as contained in the December 1, 1963, Progress Reports on Citrus and Subtropical Fruit; Deciduous Fruit and Tree Nuts; Florist, Nursery and Shade Trees; Potatoes; and Vegetables. The Progress Report material was supplemented by discussions with staff members covering demonstrations of accomplishments, plans for use of current resources through the next fiscal year, and problems requiring new or additional research.

The Committee also considered statements of the research needs in the horticultural crops field presented at the Public Session meeting by: John H. Walker, Executive Director, Society of American Florists, Washington, D. C.; Sidney B. Hutton, President, Horticultural Research Institute, American Association of Nurserymen, Inc., Washington, D. C.; Fred P. Corey, Executive Vice President, National Apple Institute, Washington, D. C.; William M. Lott, President, State Horticultural Association of Pennsylvania, Gardners, Pa.; F. Ridgely Todd, member, Raw Products Research Committee, National Cannery Association, Washington, D. C.; H. P. Schmitt, Research Director, National Association of Frozen Food Packers, Washington, D. C.; W. R. Moore, Secretary-Treasurer, Pickle Packers International, Inc., St. Charles, Ill.; A. E. Mercker, Executive Director, National Potato Council, Washington, D. C.; Henry A. Bucklin, Executive Secretary, National Pecan Shellers and Processors Association, Chicago, Ill.; Ray Bass, President, Federated Pecan Growers Association, Lambert, Miss.; O. P. Leonard, President, Texas Pecan Growers Association, Ft. Worth, Tex.; Bernard J. Inning, Secretary, United Fresh Fruit and Vegetable Association, Washington, D. C.; L. G. MacDowell, Director Research, Florida Citrus Commission, Lakeland, Florida; Herman F. Steele, Assistant General Manager, Florida Citrus Mutual, Lakeland, Florida; D. R. Thompson, European Representative of California-Arizona Citrus Industry, Los Angeles, California; L. N. Bianchini, Vice President of United Vintners, San Francisco, Calif.; National Sweet Corn Breeders Association; and the National Peach Council, Carbondale, Ill.

Dr. Nyle C. Brady, Director of Science and Education, Office of the Secretary, U.S.D.A., is Chairman of the Committee, and Dr. E. C. Elting, Deputy Administrator Research Planning and Coordination, Agricultural Research Service, is Vice Chairman.

After a careful review of all the material available, the Committee submitted the following comments and recommendations to the Secretary of Agriculture.

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Additional copies of this report may be obtained from Roy Magruder, Executive Secretary, Horticultural Crops Research Advisory Committee, Office of Administrator, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C. 20250.

## I. GENERAL COMMENTS AND RECOMMENDATIONS

Public Image of Agricultural Research. Never before has the American consumer been able to purchase so much excellent food and fiber for such a small fraction of his working time. Inasmuch as agricultural producers are becoming a smaller minority, and inasmuch as the congressional delegations of the Federal Government are becoming more representative of urban populations, we believe greater influence will be forthcoming in areas of legislation and government by the public image created for agriculture, rather than by the action of the people actually involved in agricultural production and distribution. It is unfortunate that the general public tends to look upon agricultural research as one of the farm programs supported by tax funds for the benefit of farmers. There is little realization of the major contribution that such research has made to the safe, nutritious, attractive, and economical diet that our people enjoy. The success of agriculture in its major objective, i.e., to provide our people with an abundance of low-cost, high-quality food and fiber, has been given some publicity in recent years, but the Committee feels that further emphasis is needed with particular attention to the important contribution that agricultural research has made, and is making, in the achievement of this goal.

Reduction of Funds Available to USDA for Research. This Committee is highly concerned about budget reductions proposed for F. Y. 1965 which will impair progress being made in very important fields of agricultural research. We are fully in accord with desires for economy in Government; but the fact must be recognized that effective research is not something that can be turned off and on intermittently if we are to expect and receive expert tangible results.

The results of research now planned and in progress will insure this Nation's food supply, and the health of its people, in all the next succeeding generations. Research must be systematically and intelligently expanded to reap the harvest of the program.

The research programs being conducted in the Agricultural Marketing Service, the Economic Research Service, and the Statistical Reporting Service are making important contributions to our knowledge of proper handling, transporting, marketing, and use of horticultural products. The recent drastic and arbitrary reduction in the funds projected for fiscal 1965 will destroy much of an important research program that has been developing over a period of years which has been recommended for support by the Research and Marketing Advisory Committees. This Committee is deeply disturbed by the disastrous effect which this reduction will have on the future of the research efforts on handling, transportation, packaging, and consumer use of horticultural crops and urges all segments of Agriculture to seek the restoration of these much-needed funds to the fiscal 1965 budget.

Mechanical Harvesting, Mechanical Harvesting Aids, Biological Aspects of Mechanical Harvesting. With the discontinuation of Mexican Farm Labor Importation Program (P.L. 73), it becomes imperative that a greatly accelerated research program of mechanical harvesting of vegetables and tree-fruits, be pursued with the cooperation of all agencies involved. With many



vegetable crops and tree-fruits, harvesting is the most costly operation, and without supplemental labor it becomes disastrous, with attendant high cost to the consumer. This Committee feels that there should be a greatly increased research program in the area of mechanical harvesting and handling of horticultural crops.

Biological Control and Pesticide Residues. The Committee wishes to compliment the Entomology Research Division for the imaginative approach to new methods of insect control. The Committee is well pleased with the progress attained to date. A number of important insect pests of horticultural crops are not adequately controlled by present insecticides. In others, control cannot be attained without residue problems. Known also is the increased resistance of insects to heretofore effective insecticides. There is a need to expand research on the feasibility of controlling key insects by the male sterilization techniques and other biological methods.

There should be continued emphasis on developing new methods of controlling, reducing, or otherwise minimizing the hazards of pesticide residues.

Research is needed, perhaps in cooperation with the Department of Health, Education and Welfare and the Federal Aviation Agency, on methods of minimizing or eliminating crop damage from drift of airplane-applied pesticides.

Air Pollutants on Yield and Quality of Horticultural Crops. It is becoming increasingly clear that crop damage caused by air pollutants arising from industrial and auto exhaust sources is not confined to the Los Angeles basin and is a growing national problem associated with the accelerating trend to urbanization and industrialization in many areas. The pioneering agricultural air pollution research project being conducted by the University of California at Riverside supported cooperatively by industry, agriculture, county governments, and the University, merits further strong, direct, and substantial support from the U.S.D.A. through grants, contracts, and other available means. The knowledge gained would provide guidelines for the development of a broadly-based, long-range program within the U.S.D.A. on the cause and control of air-pollution damage to crops.

Assistant Secretary of Agriculture for Research and Education. The Committee is gratified to note that the Secretary of Agriculture's appreciation of the importance of agricultural research is evidenced by his request to the Congress for the creation of the post of Assistant Secretary for Research and Education. This Committee congratulates the Secretary for having a staff member now functioning in this capacity as Director of Science and Education.

Commodity Credit Corporation Funds. Funds available to research agencies in the Department of Agriculture have traditionally come from Federal appropriations for agricultural research. New funds made available for research through transfer from the Commodity Credit Corporation during fiscal 1964 are of utmost value in financing high-priority research projects. Every effort should be made to obtain these funds on a continuing and increasing basis.

Fermentation of Fruit Juices. New products are needed to increase outlets for all our fruit crops. Research should be initiated toward obtaining new fruit products through fermentation and other measures.

Ornamental Crops Research. The progress being made in the Department of Agriculture in increasing the research efforts in ornamentals is most gratifying. Rapidly expanding urban and suburban interest in growing ornamental plants of all kinds for home, street, park building, and industrial site development imparts economic urgency to solutions of the problems in the industry. Expanded fundamental and applied research in ornamental crop research is needed to develop types and to avoid losses due to crop failure, unpredictable and uncontrolled plant growth, and diseases.

Pecan Research Manpower. The present serious imbalance in research man-years devoted to pecan culture and marketing, as compared to other crops of much less farm values, should be corrected within the next two years. Unless action is taken at once, the personnel presently responsible for the limited research now in progress will be gone from the scene and the value of their experience lost to their successors.

## II. COMMENTS AND RECOMMENDATIONS ON CURRENT PROGRAM AND NEEDED RESEARCH

In recommending new or expanded research on problems listed in this section, the Committee recognizes that it is not its responsibility to delineate between research to be conducted within the Department and that to be conducted in cooperation with State Agricultural Experiment Stations and other research organizations. The recommendations made by the Committee are based on their judgment that the problems are important and that research is needed by the Department on them. The Committee did not establish any priorities as to importance of problems recommended.

### FARM RESEARCH

Breeding Improved Varieties. This Committee wishes to emphasize its approval and encouragement of the program for breeding and development of new and better varieties of horticultural crops. There is need for acceleration of phases such as basic genetic studies which provide more efficient tools for the use of plant breeders, in introducing disease resistance, better processing quality, improved cold tolerance, adaptability to specific climatic conditions, and so forth. There is need in all ongoing horticultural crops breeding programs to give greatly increased emphasis to developing varieties having characters that adapt them to the special requirements of mechanical harvesting.

Small fruits. The value of small fruits, namely, grapes, strawberries, blueberries, raspberries, blackberries, cranberries, and other small fruits, is important in every part of the nation. Thousands of small producing units as well as larger producing units have created useful and needed products in the fresh and processed fields. These fruits add to the health and enjoyment and raised standards of diet of the consumer. Income to the growers and the many associated workers is no small item in almost every community throughout the country.

The growth of the importance of these crops because of new varieties and methods is dramatically illustrated by the record of the past 10 years. By the very nature of these crops, under present methods of cultivation, new and improved varieties have been a primary factor in the expansion of production, use, and dollar value. Continued and expanded breeding and research with these crops is absolutely necessary. Without this the collapse of the industry would be assured within a very few years. Any interruption of the breeding program would be very costly and disastrous. The program is valuable and must be continued.

In addition to the value of this work to the industry, the Committee wishes to underscore the importance of the income created for hundreds of thousands of people by the part-time use or full-time use of their time to produce and harvest these crops. As we wage war upon poverty, these crops are a small but significant factor serving a valuable purpose.

Tree fruits and vegetable crops. In these crops the special needs are for disease resistance, better processing quality, and improved eating quality, better adaptation to specific climatic conditions. Breeding work aimed at developing resistance to specific major insect pests should be greatly accelerated.

Ornamental crops. In this area there is need to greatly accelerate breeding efforts to produce improved varieties of landscaping plants resistant to adverse weather and to pests, and which have special adaptation to container culture and the poor soil conditions usually found in new housing developments.

In breeding ornamentals, consideration should be given to an adverse factor of increasing importance in and near centers of population--air pollution. It is clear that resistance to air pollutants is going to be of major importance in the selection of landscaping materials in the urban areas in the future.

Disease Control. The aggregate losses annually caused by diseases of horticultural crops are still enormous. Associated with outright loss of production is depression of quality. These losses are reflected not only in lower returns to the producer, but also in higher prices to the consumer.

This Committee is impressed with the tremendous advances that have been made in control of diseases of horticultural crops by scientists of the Crops Research Division of the ARS. Nevertheless, we believe that disease control problems are never-ending and that efforts in this area should be given to studies on the mechanism of pathogenic action of specific fungi, bacteria, and viruses that afflict horticultural crops. Also, much greater resources should be assigned to pesticide residue research. In citrus, deciduous tree and small fruits, greater support should be given to virus diseases, with strengthening of research on means of eradication of viruses from valuable clones. In vegetables, there is need for strengthened research on the diseases attacking carrots, onions, beans, lima beans, peas, spinach, tomatoes, peppers, potatoes, melons, and mushrooms.

The development of biological control methods for soil-borne diseases of vegetables merit greater emphasis.



Weed Control. With labor becoming critically short in all areas, increased emphasis on chemical weed control research is needed. Special efforts should be put forth to cut down the time lag between successful work on an experimental basis and clearance by the F.D.A. for use of the method or material in the field.

Great progress has been made, and the Department is complimented on it, but there are still many unanswered basic questions in the field of chemical weed control:

Why is there more injury to one plant and not to another of the same variety? can resistance to injury be bred into the plants?

How do environment factors influence effectiveness of a control program?

How and why do herbicides influence flavor?

Will the synergistic effects of residual herbicides in soil over a period of time become a problem?

Close cooperation with the Engineering Research Division is needed to develop application equipment.

Nematode Control. Long-lived orchard and vineyard crops are often seriously reduced in vigor, quality, productivity, and effective productive life by a wide variety of nematodes parasitizing root systems, often sensitizing them to further damage by fungi and adverse soil conditions. There is need for strengthening research on methods of suppressing nematode damage to established trees and vines by chemical or biological methods of treating the soil. For vegetable and flower crops, more research is needed to speed up the development of preplanting biological or other non-residue producing methods of soil treatments for nematode control.

It is recommended that consideration be given to the establishment of a pioneering laboratory for basic studies on the biology of nematodes with emphasis on mode and physiology of reproduction, the mechanism of pathogenic action on plants, and the nature of resistance or tolerance of plants to nematode damage.

Physiology and Culture. The remarkable advances in knowledge during the past decade concerning the physiology and biochemistry of growth, metabolism, and fruiting in plants have led to many new cultural practices for horticultural crops. Sufficient progress has been made in the use of growth-regulating chemicals to demonstrate the extraordinary promise of this means of controlling plant growth and metabolism to warrant greatly strengthened support in this area. It would appear to be a very fruitful approach to the solution of such problems as biennial bearing of tree fruits and nuts, low cold tolerance due to lack of dormancy of citrus, poor potato tuber development and maturation due to unfavorable weather, difficulty in separation of fruit from the plant in mechanical harvesting of fruits and vegetables, the handicap to breeding of the long cycle between seed germination and fruiting of most fruit and shade trees, to name a few examples.

There is need for greatly strengthening basic studies on the effect of the various elements of climate on the growth and fruiting of horticultural plants. Currently the regions in which various varieties or species do well are reasonably well identified, but the critical aspects of the climate that govern such adaptations are not clearly defined. Basic knowledge of this kind would be of great value in breeding plants for specific climatic zones.

Other areas of research that merit substantial strengthening are: for deciduous tree fruits, root stock improvement, control of York Spot and bitter pit of apples; for vegetables, effects of herbicides and pesticides on maturity, quality, and flavor of the product; for potatoes, studies on black-spot, stem-end discoloration and after-cooking blackening; and the nature of differences in frost hardiness among varieties and species of tree and vine fruits, but especially among citrus varieties and species.

Control of Insects and Pests. The Committee highly recommends the continuation of the work of the Entomology Research Division in seeking both practical and theoretical solutions to insect problems. Dramatic successes in eradication of melon fruitfly, Mediterranean fruitfly, and screwworm pests over large areas have more than compensated for the investment in research.

Insecticides, biological controls, attractants, insect sterility, all are playing important parts in the never-ceasing war on agricultural losses due to diseases and pests. Without doubt, we are just beginning to understand the tremendous potential of controlling insects by other than chemical means. Careful planning for expansion of such work and increased appropriations for acquisition of additional top scientists in these areas are vital. American agricultural production must remain competitive in world and home markets.

Very little is known about many of the insect vectors of virus diseases. Viruses and nematodes cause millions of dollars of loss every year. Additional knowledge must be sought.

Cooperation between the scientists seeking control methods and the breeders to develop resistant varieties is already producing results. This is of national importance and should be encouraged.

Research in entomological and biological solutions to pest problems should go hand in hand with the chemical control studies. These problems are basic to all types of agriculture including vegetables, potatoes, citrus fruits, subtropic fruits, deciduous fruits, small fruits, tree nuts, flowers, shrubs, forest and landscaping trees, grasses and turfs. We have special concern for the problem of spider mites, Japanese beetle, codling moth, oriental fruitfly, Mediterranean fruitfly, melon fly, Brown soft scale, aphids, wireworms, loopers, earworms, borers, drosophila as well as others. We cannot overemphasize the need to continue and increase this work.

Agricultural Engineering Research. The contribution of the engineers of the USDA in design of equipment, facilities, methods, and processes has always been a great boon to American agriculture and industry as well as the public. Costs of production are going up. Labor sources for adequate agricultural use have been shut off or are drying up. Labor-saving, time-saving devices and equipment, especially in planting and harvesting of crops, are absolutely necessary.

Although the basic methods of harvesting potatoes from stone-free soils have been developed, nothing has solved the problem of harvesting potatoes in stony or cloddy soils. Basic knowledge is essential to solve this problem, and we urge immediate work on the problem.

The principles of mechanical and selective harvesting are just beginning to be studied. Further work is urgently needed for all types of horticultural crops. The cooperation of plant breeders is of prime importance in development of varieties adaptable to mechanical harvesting. We recommend increased support to accomplish these objectives.

Our Committee urges further studies be made by the engineering specialists to see if insect and pest control methods might be developed through practical use of rays, wavelengths, and other electronic devices.

The ultimate has not been reached in application of sprays, dusts, fertilizers, waxes, and other materials. If funds are not available for research in these areas, we recommend the USDA work as a clearing house for knowledge of equipment and methods developed by the State colleges, industry, and individuals. Much saving in time and funds would result if such information were known to be available at a specific source.

Biological Aspects of Mechanical Harvesting of Citrus. The Committee is gratified to note a \$50,000 increase in the F.Y. 1964 budget allotment for this research. This was supported by a recommendation included in the 1963 report of the Citrus Research Advisory Committee. The key sentence was as follows, "Personnel and support should be added to conduct research on both pre-harvest and post-harvest aspects such as fruit abscission, tree pruning and shaping, and effects of mechanized systems on shipping and market qualities." Further we note that the entire \$50,000 was allotted to the Agricultural Marketing Service, which is concerned only with the post-harvest aspects of this problem. We recommend that consideration be given to dividing this amount between AMS and the Crops Research Division of ARS, so that work can begin on the vitally important pre-harvest aspects of the problem.

#### NUTRITION, CONSUMER AND INDUSTRIAL USE RESEARCH

Human Nutrition and Consumer Use Research. This Committee understands that some feeling exists that nutrition research should not be done within USDA or that it should be curtailed within the Department. The Committee feels that the nutrition research work is one of the best methods of improving the image of agriculture. Cost of food comparisons with similar nutritional qualities need to be much more highly publicized. Such comparisons against other "cost of living" items must be maintained and talked about. It is the



Committee's feeling that good copywriters and public relations experts could use the information from this group to vastly improve the image of the Department and offset the negatives that have been so widely quoted about the U. S. food quality and supply situation. The data must be accurate, timely, unbiased, and in great volume.

Plant breeders must depend on nutritional analyses to guide their varietal selections.

USDA Handbook No. 8 is the classic and most complete authoritative source of food composition tables. It is a never-ending task to keep this publication up to date. Revisions including newer foods, newer processing methods, and newly-recognized nutritional factors must constantly be made. This book is the "Bible" for dietitians, home economists, and that part of the medical fraternity that prescribes diets.

Research to determine how quality factors are effected by processing in home and in institution preparation methods must continue, and such results must be widely publicized.

Unless the Administration is adamant on setting up a cabinet-level "Consumer Department," we recommend that the expanded research program proposed on nutrient value of foods, tables of food composition, quality characteristics of fruits and vegetables for consumer use, food product evaluation, metabolic responses to diet, food consumption surveys, and on food habits be adopted as a minimum program.

Utilization Research and Development. The programs of the Utilization Research and Development Divisions, ARS, are extremely important to this Nation's progress. The achievements made by these Divisions in recent years cannot be measured in dollars, and this kind of basic research must be expanded. It is gratifying to note that proposed budgets allow for expansion of facilities in this direction.

This Committee has witnessed a very comprehensive briefing by USDA scientists in regard to present programs being carried on, as well as areas where new investigation and additional research are recommended.

In general, this Committee concurs in the programs as outlined and presented for Citrus and Subtropical Fruit, Deciduous Fruit and Tree Nuts, Potatoes, and Vegetables. We wish to stress the importance of adequate research efforts in the following problem areas with regard to these horticultural crops:

Chemical Composition and Physical Properties. A knowledge of both major and minor chemical constituents, the physical structure and properties, and the chemical and physical changes that occur in the maturing and processing of horticultural crops is needed as a basis for the development of new and improved products and in the improvement of processing technology. Research should be expanded on (1) chemical constituents responsible for flavor, color, aroma, texture, and nutritive value; (2) the nature of the chemical changes these substances undergo resulting from pretreatment, processing, and handling that lead to the formation of off-flavors--colors, odors, and



objection texture; (3) the determination of physiological activity of components through use of laboratory animals. (4) The Committee compliments the Western Utilization Research and Development Division on the very substantial progress made in recent years on the chemistry of the bitter principles in Navel oranges. In view of the limited resources assigned to this project, the progress to date is especially gratifying. It is recommended that additional manpower and appropriate supporting resources be assigned to this project so that basic information on the structure, reactions, and methods of assay, of the compounds responsible will be developed as rapidly as possible. Hopefully, such information will provide the key to the development of a practical means of debittering processed Navel orange juice, and thus open up this profitable byproduct outlet to the Navel orange industry.

New and Improved Processed Food Products. The changing tastes of the consuming public require the continuing development of food products of convenience and high-level acceptability in order to retain traditional and develop new markets. Greatly increased costs of transporting, storing, and handling are making it more economical to market in concentrated forms. Research should be expanded to develop desirable and stable products of (1) avocado, papaya, guava, passion, lychee, and mango; (2) of deciduous fruit products in liquid concentrates, semi-solid, quick-cooking dehydrated pieces and powdered forms for storage in frozen form, under household refrigeration or preferably those stable at ordinary temperatures; (3) new products from fresh potatoes or from stable intermediates such as dehydrated slices, flakes and granules, quick-cooking potato dice and other pieces, nutritious low-fat potato containing dietary foods and stable food concentrates for export; and (4) of vegetables including dry beans, peas, green leafy vegetables, sweetcorn, sweetpotatoes, tomatoes, carrots, celery, okra, and cucurbits. Research should be initiated to determine the feasibility of using Thompson Seedless Grapes and other varieties in the development of fermentation products.

Improved Processing Methods and Equipment. Continuous development research is necessary to improve processing efficiency and develop equipment and processes that enhance product acceptability, stability, and other quality factors. The physical concepts and engineering aspects of all processes must be continuously evaluated in the light of basic research findings to reduce processing costs. Both basic and applied research should be expanded and directed toward (1) reducing the severe conditions required to inactivate spores of food spoilage organisms during heat sterilization; (2) reducing the adverse color and texture changes that occur as a result of freezing and dehydration operations; (3) controlling processes to produce uniformly high products from raw material that is variable because of varietal selection and the effects of agronomic practices in production; (4) developing processes for utilizing products of excellent food quality but unfitted for fresh market because of size, shape, or other non-harmful physical condition; and (5) developing instruments and techniques for the objective measurement of quality attributes preceding, during, and following processing. Additional research is needed on the following commodity problems: eliminating or modifying bitterness of grapefruit and Navel orange products; enhance stability of dehydrated and frozen fruit products and shelled nuts; improve the texture of frozen strawberries; reduce amount of additives in dried fruits to better suit the export market; improve freeze drying,

vacuum drying, dehydrofreezing and foam-mat drying of fruits; improve processing of all potato products; and improving the texture and color of vegetables preserved by fermentation, especially cucumber pickles.

Processing Characteristics of New Varieties. The quality potential of a variety for the various kinds of processing is a very important factor in commercial processing. Because of the increasing proportion of fruits and vegetables being marketed in processed forms, it is imperative that new varieties be evaluated for their suitability for processing as well as for their fresh market characteristics. Research should be expanded in cooperation with plant breeders to evaluate both established vegetable varieties and plant breeders' lines and all promising new citrus selections for their processing characteristics before widespread propagation. Include also studies of various rootstocks and rootstock sources, cultural practices, and other physiological responses of the bearing trees in their relation to processing quality.

Prevention of Microbial Deterioration. Processors of horticultural crops encounter considerable losses through microbial deterioration and spoilage prior to and during processing and in the channels of trade. Research on microbial deterioration should be expanded in order to develop procedures for eliminating these losses by modifying the processes or processing equipment and through application of non-toxic chemical inhibitors of microbial contamination and buildup in order to reduce or prevent losses, deterioration, and consequent lowering of quality. Research should be conducted on the control of brown rot during post-harvest ripening of fruits for processing, and investigations on factory sources of microbial contamination and their control should be expanded.

#### MARKETING AND ECONOMIC RESEARCH

Objective Measurement of Quality. Improved instruments, devices, and techniques for the measurement of quality during distribution will improve inspection, grading, and standardization; lead to more appropriate price differentials for farmers who produce high-quality produce; decrease disputes between buyer and seller; and promote consumer satisfaction. Present research should be expanded to provide for a continuous development of new devices and methods, non-destructive in nature, with automatic separation possibilities, for the determination of quality in fruits, vegetables, and ornamental plants and their subsequent pilot scale testing in the field. For citrus fruit and avocados, better instrumentation and techniques are needed to measure internal and external color, flesh texture, and composition as related to eating and storage quality. Pilot-scale field testing is needed of devices for detecting water core, internal browning or brown core in apples and internal bruises in red cherries and for following internal color development and maturity of plums and peaches. Measuring susceptibility to bruising of fresh market potatoes and non-destructive identification of such disorders as russet spotting and tipburn of lettuce and black leaf speck of cabbage are important problems.

Better instrumentation and techniques are needed to more accurately determine the pounds of solids of citrus automatically without destroying the fruit.



There is need for rapid methods of determining the characteristics of potatoes for different uses. Research should be expanded on developing objective methods of quality determination for specific uses of potatoes for processing and for the fresh market, particularly for methods that might be adapted for use in grading and inspection. Research on instruments and methods to predetermine susceptibility to bruising of fresh market potatoes should also be expanded. There is a need for a practical method of determining chip color by the inspection service so that color may be incorporated into contracts for chips.

Control of Postharvest Diseases. Decay that occurs in horticultural crops during marketing is particularly costly for, in addition to the loss of food, the substantial investment involved in harvesting, packaging, transportation and sale is largely lost. Studies should be expanded (1) to determine the mode and time of infection, the basic tissue changes which precede visible decay and methods for decay reduction, with particular emphasis on heat treatments, protective packaging, effective precooling and optimum environments for preventing decay of vegetables; (2) in Florida, California, and Texas to elucidate host-parasite relationships; to evaluate hot water, infrared and other treatments for decay inhibition; to determine the effect of mechanical harvesting on fruit damage and subsequent decay and to more firmly establish optimum postharvest precooling practices and holding temperatures for citrus and subtropical fruits; (3) to determine commodity temperature and exposure tolerances to hot water and saturated hot air and to survey inhibitory treatments for the numerous decay organisms involved in decay of deciduous fruits. Work should be continued on packaging, transit services, and decay prevention for cut flowers and florists' greens.

Basic Research in Postharvest Physiology. The physiological and compositional changes that occur in horticultural crops immediately preceding and after harvest must be better understood and the effect of environment on these changes known, before any further substantial advances can be made in the prevention of commodity deterioration and loss during storage and marketing. Increased basic knowledge of the processes of ripening, aging, and the malfunctions leading to physiological disorders should result in better quality for the consumer, less wastage in market channels, and lead to improved storage and packaging methods. Research in postharvest physiology and storage should be expanded with emphasis on (1) determining the physiological nature of the functional changes which cause pitted, dried, or discolored rind areas, the environments which affect their incidence, and methods of predetermining susceptibility to rind breakdown in citrus; (2) the physiology of ripening and aging of deciduous fruits related to respiration, biochemical changes, and composition of the surrounding atmosphere; (3) the relationship of temperatures during the growing season on postharvest storage disorders of pears in cooperation with Oregon State University; (4) finding the optimum concentration and combinations of oxygen, carbon dioxide and nitrogen at different temperatures to extend the storage and shelf life of stone fruits and berries;



(5) basic research on the postharvest physiology of potatoes for an intelligent appraisal of internal black spot, after cooking darkening, and internal sprouting, studies of the biochemistry and physiology of starch and sugar interconversions and other fundamental changes would also be involved; (6) basic studies on the nature of aging; the physiological processes which precede such postharvest disorders as russet spotting of lettuce, color fading in green beans; chilling injury in sweetpotatoes, peppers, cucumbers, tomatoes; the activity of enzymes and enzyme systems; and the effect of decreased oxygen and/or increased carbon dioxide in the atmosphere on keeping and eating quality.

Determination of Chemical Residues. In view of the present concern about chemical residues, in both domestic and export markets, there needs to be a substantial strengthening of research on analytical methods and quantitative determination of natural and added materials which now are, or might be, subject to scrutiny and cause for seizure and condemnation by regulatory bodies.

Control of Insects that Attack Dried Fruits and Tree Nuts. Improved procedures are needed to prevent or control insect infestation and damage in dried fruits and tree nuts. The need is emphasized by the demands of the public and of food processors for a pure, wholesome product, and by Food and Drug requirements for freedom from insect contamination and objectionable pesticidal residues. Research should be expanded on the development of (1) more effective materials and improved application methods so that a minimum amount of pesticide will be required to protect dried fruits and tree nuts during processing, storage, and transportation, (2) more effective insect-resistant packages for dried fruits and tree nuts, and (3) procedures and schedules for bulk and in-package fumigation of dried fruits and tree nuts. Basic and applied research should be initiated on (1) the biology, ecology, and physiology of the insects that attack dried fruits and tree nuts, (2) a study of the insect problems associated with the infestation of dried fruits in warehouses, rail cars, and ships' holds, the sources of such infestations, and ways to prevent them, (3) more effective ways of preventing the contamination of dried fruits with insects or insect fragments and more efficient methods for removing such contaminants as may occur, and (4) the development of nonchemical preventive or control measures such as irradiation, insect pathogens, temperature, and inert gases; and of non-pesticidal chemicals such as attractants, repellents, and physiological control agents.

Quality Maintenance in Storage of Potatoes. A high percentage of the potato crop is now stored for processing--usually at temperatures higher than are used for seed or table stock potatoes. Research should be expanded to determine the temperature and other environmental conditions needed for storage of potatoes that will be made into processed products such as chips, granules and flakes. Research is also needed on effects of rate of air movement and relative humidity on decay, weight loss, shrinkage and other deterioration at these high temperatures. Additional research is needed on possibilities of pallet box storage as a means of controlling pressure bruises and internal black spot.

Precooling and Transit Refrigeration of Leafy Vegetables. These highly perishable products incur substantial losses from both decay and physiological disorders between harvest and consumption. Research with these commodities should be strengthened to determine the effect of trimming and wrapping (field, packinghouses, shipping point, or terminal) and consumer package type on quality maintenance; to improve cooling and handling procedures; and to evaluate different load patterns, transportation equipment and protective services for preservation of quality in transit.

Improved Methods, Equipment, and Facilities for Handling, Storage, and Packing Fresh and Processed Fruits, Potatoes and "Mixed" Loads of Vegetables. The increasing scarcity and cost of labor for handling, storing, and packing horticultural crops coupled with the increased rate of arrival at the packing house due to partial mechanization of harvesting and field handling has focused attention on the problem of lowering costs in handling, storage, and packing. Many of our present packing houses contain antiquated equipment, are poorly arranged, and have insufficient holding areas for present-day volumes and quality requirements.

Engineering research work should be initiated or expanded (1) in the Fresno, California, area to reduce the cost of handling and packing of soft fruits and tree nuts for the fresh market as well as in canning, freezing, and drying plants; (2) on potato storage problems in both late summer and fall crop areas of semi-arid regions of the West to determine optimum air flow rates and humidity conditions, and to develop ventilation systems and humidifiers which will provide the desired rates and conditions at minimum cost. Engineering design work should be undertaken to cover the development of detailed plans and material specifications for at least three types of potato storages and two types of packinghouses. In the principal areas where mixed loads of vegetables originate, there is need to develop improved methods and equipment for packing "mixed" loads of several kinds of vegetables, and to develop improved layouts and designs for packinghouses.

Improved Packages and Shipping Containers for Fruits, Vegetables, and Flowers. As presently packed, many of our choicest fruits, vegetables, and flowers all too frequently are crushed, bruised, discolored, wilted, or generally lacking in sales appeal when they reach retail stores both at home and abroad. Even our better packages and containers were developed for domestic shipments by rail and truck, and many of them are ill-adapted for air and overseas transport. To combat increasing competition in world markets and rising costs at home, more emphasis should be placed on developing cheaper, lighter, stronger, and more protective packages and containers specifically designed to maintain optimum temperatures and humidity in either domestic or foreign shipments by land, air, or sea. Expanded research is needed on new methods of preparing and packaging fresh fruits and vegetables such as trimming off excess parts to reduce weight.



Improved Transportation Equipment and its Use. Transportation is one of the large expense items in the distribution of fresh produce, and additional research is needed not only in the development of new or improved equipment more nearly meeting present-day requirements but in the development of methods for more efficient use of recent advances in transportation and economic-engineering research. Research needs to be expanded on (1) the development of transport refrigeration that will have fewer breakdowns, be lighter in weight and less costly to purchase and operate than the present mechanical systems; (2) improving the designs of freight cars, truck and piggyback trailers and transferable van bodies and multipurpose vehicles better adapted to new forms of integrated transportation with special attention to overseas shipments, including mechanical loading and unloading and adequate protection of the products moved in them; and (3) reducing costs by better utilization of available transportation equipment and services through studies with (a) larger and more efficient freight cars, trucks, and aircraft, (b) new operating methods such as integral trains, heavier loading, unitized and palletized handling and loading, and (c) new forms of coordinated transport and handling, including piggyback, fishyback, and containerization.

Improving Operating Methods of Cooperatives. The rapid changes taking place throughout the marketing system make operations of cooperatives and other marketing organizations more complex and difficult. To better serve the changing needs of the market as well as meet farmers' marketing problems in the modern distribution system, research is needed in the areas of improving operating methods, pooling, and pricing. Grower cooperatives need to improve the efficiency of their internal operations as well as develop more effective operating methods in the market. Work is needed especially in the areas of management and sales methods. The methods used by cooperatives to pay growers for their produce can have an important influence on how well production is adjusted to meet market demands, as well as on the long-run returns to growers. Research is needed on various pooling and other grower payment methods that will evaluate their effectiveness under various price conditions, and with commodities having different degrees of storability.

Market Potential for Foam-Mat Dried Orange Juice Powder. Research should be expanded to permit an early evaluation of market acceptance of this new product to aid in guiding further developmental research. An identification of the location and size of prospective market will be of considerable value in guiding commercial production by the industry.

Market Potential for Frozen Avocado Salad. The development of a process for freezing avocado salad at the Southern Utilization laboratory, Weslaco, Texas, offers a potential for fruit unsuitable for the fresh market, for extending the marketing time and enlarging the total market for avocados. Research should be expanded to permit an evaluation of the market potential for this product so as to provide a basis for market development and expansion when trees damaged by recent freezes recover and when new plantings come into production.



Market Potential for Instant Sweetpotato Flakes in the Retail Market.

Results of recent institutional market test of sweetpotato flakes indicate a good market potential exists for sweetpotatoes in institutional outlets. Expanded research is needed to evaluate the full commercial feasibility of the product in the household market and perhaps hasten its commercial adoption in this outlet.

Maximizing Returns from Promotion. The horticultural industry currently spends many millions of dollars annually for promotional activities designed to maintain and enhance the market for their products. One of the major problems confronting this industry is the proper allocation of the budget to the many alternative promotional methods which are available. Research, with substantial support from industry, should be undertaken to study the methodology for determining the effectiveness of various promotional methods and their combinations at different levels of expenditures.

Merchandising and Promotion of Horticultural Crops. Today most food products are purchased in self-service retail food stores where products are their own salesmen and unplanned or impulse purchases account for a significant volume of consumer expenditures. Because producers often have little or no direct control over the manner in which their products are offered at retail or contact with customers, a research effort is needed to provide information that will permit increased responsiveness to demand and the adoption of mechanizing and promotional practices that will be most effective in maintaining and increasing the demand for deciduous fruits and nut fruits. In the spring of 1962, the National Peach Council embarked upon a new area of promotional activity of making point-of-purchase material available to the distribution industry. It is recommended that research be expanded to include an evaluation of the effectiveness of alternative promotional approaches to provide the industry with guidelines that can be used in allocating the promotional budget between various kinds of promotional activity.

Marketing Horticultural Specialties. The market for flowers and nursery products is unorganized relative to other agricultural products and deserves greater research emphasis. The florist industry is devoting considerable attention to expanding the market for flowers through advertising, merchandising, and promotion. The industry has contributed \$40,000 to initiate research designed to provide some basic economic and marketing information and to study the role of advertising, merchandising, and promotion in expanding the market for flowers. This research should be expanded to include similar research for ornamentals and other nursery products. This research is urgently needed to assist growers, shippers, wholesalers, and retailers of horticultural specialty crops to adjust to changing marketing practices and conditions.

Commodity Situation and Outlook Analysis for Horticultural Crops. Faced with the prospect of reduced supplies of citrus fruit over the next few years as a result of freezes last winter, the citrus industry needs additional information. More knowledge is needed of price and consumption responses under different supply and demand conditions for each citrus product to aid in making decisions on the allocation of

the total supply to the various products and markets over time and within seasons in a way that will maximize dollar returns. Work would involve determining what the price-consumption responses are for each type product, the competitive relationships among these citrus products, and the relationship between citrus and noncitrus (including synthetic) products. More attention should be devoted to the regional aspects of potato production, marketing and prices, with further delineation of kinds of potatoes and whether marketed fresh or processed would improve the usefulness of potato situation and outlook work.

Consumer Quality Discrimination. Research should be expanded on consumers' ability to discriminate among, and preferences for, selected attributes of quality and flavor in agricultural products such as vegetables, fruits, and fruit juices. Such studies aid industry in planning efforts for more effective marketing, provide an evaluation of possible consumer acceptance of new developments or variations, and give direction to laboratory research designed to develop agricultural products with greater appeal and usefulness to consumers. Such research would also be helpful in evaluating grade standards in terms of their reflection of consumer satisfaction with the product.

Consumer Food Habits and Fads. Research should be initiated to determine who within a family eats or rejects selected foods and the underlying reasons for these choices, including the extent to which certain foods are chosen or rejected because of an individual's concern about gaining or losing weight or other health problems. The study should also investigate the effect of restrictive diets for some family members on consumption by other family members of specific foods and whether the restrictive diets were prescribed by professionals or by the individual himself. Such research is essential to understanding and interpreting patterns of food consumption.

Consumer Preferences for Horticultural Products. As an aid in planning efforts to market horticultural products most effectively, the industry needs to know why, when, how, and what the homemaker buys, and what her reactions are to variations in such factors as the forms in which the products reach the market place, prepackaging, package size, varieties, and quality. Research should be initiated to determine household consumers' opinions of, and preferences for, various forms, reasons for use or nonuse, factors associated with high and low levels of consumption, usages, and buying practices for citrus fruits, avocados, vegetables, cut flowers, potted plants, and landscaping plant materials. For the potatoes, the study should include substitutability among potatoes, rice, and selected grain products or the competition from other foods.





